Southwest FISHERIES SCIENCE CENTER

HONOLULU LA JOLLA MONTEREY TIBURON

REPORT OF ACTIVITIES September-October 1993

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ANTARCTIC ECOSYSTEM RESEARCH GROUP

La Jolla, California

Meeting Held for Working Group on Fish Stock Assessment

The Scientific Committee of the Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR) has established a permanent Working Group on Fish Stock Assessment (WG-FSA) that meets each year to prepare reports on the status of commercially targeted species in the Antarctic. These reports are in turn used by the Commission of CCAMLR to manage the various Antarctic fisheries. This year's meeting of the WG-FSA was held in Hobart, Australia, from October 12 to 21, 1993. The Antarctic Ecosystem Research Group's Chief Rennie Holt and Fishery Biologist George Watters attended the meeting for the U.S. delegation.

At last year's meeting, considerable time was spent discussing a new Antarctic fishery which targets crabs. The fishery was initiated in the waters around South Georgia Island in 1992 by a U.S. fishing company, Golden Shamrock, Inc. Two species of crabs, *Paralomis spinosissima* and *P. formosa*, were fished from a single vessel, with *P. spinosissima* being the most abundant species in the catch. Golden Shamrock has made clear its interest in continuing to fish for crabs in this area, and because South Georgia is within the designated CCAMLR treaty area, the United States will require that the company comply with any protective management measures adopted by the treaty.

At the 1992 WG-FSA meeting, various short-term protective measures for the crab fishery were formulated and adopted; these included limits on fishing effort, as well as specifications for minimum carapace size and gender of crabs that could be retained (only males) from catches. In addition, the working group agreed that a long-term management plan should be developed and discussed at the 1993 meeting of the WG-FSA.

Responding to this directive, Watters presented two papers at the 1993 meeting. In the first paper, using data from the 1992 crab fishery, Watters developed a unique analysis of daily depletion and recovery of local crab stocks in response to harvesting. Selecting the best fit to the data from a variety of recruitment models, he calculated an optimal total allowable catch (TAC) of 300 tons. However, this analysis was limited to small temporal and spatial scales (about 4 months and 3,600 nmi^2).

To extrapolate the estimated TAC to larger areas and to facilitate the development of a long-term management plan, Watters presented a second paper that describes an experimental crab fishery designed to elucidate the population dynamics of *P. spinosissima*. Keeping in mind that the fishing scheme would have to be carried out by the crab fishermen themselves, Watters attempted to design a fishery that would answer a priori questions about the crab's population dynamics and allow for a profitable fishery. Certainly, if the proposed scheme projected too severe an economic burden on the fishermen, they would discontinue fishing operations.

The proposed experimental fishery attempts to answer a number of questions:

- What are the large-scale distribution patterns of *P. spinosissima* around South Georgia Island?
- Will this pattern change during the course of the fishery?
- Are there local centers of aggregation, and if so, where are they located?
- How do local areas recover after an intense depletion episode?
- Do monthly size frequency shifts seen in data collected during the 1992 season represent recruitment via movement or dynamics in catchability?

The experimental scheme consists of three phases to be conducted over a period of two years/fishing seasons. Every vessel that participates in the fishery will be required to complete each phase without cooperation from any other participant in the fishery (that is, vessels cannot "pool" their efforts to complete phases). Phase 1 occurs at the start of each vessel's first fishing season and is a "survey" regime where fishing effort is artificially distributed over a large area. This phase will require fishermen to gather crab distribution and abundance data which are currently unknown. After Phase 1, normal fishing operations continue until the fishery's TAC is obtained and CCAMLR closes the fishery for that particular year. Phase 2 starts at the beginning of the second fishing season and, during this phase, each vessel is required to deplete three local areas. Data gathered during this phase will provide information on crab movement

rates. These data could also be used to make local estimates of abundance. After Phase 2, normal fishing operations are conducted until CCAMLR initiates closure of the second fishing season. Phase 3 commences just prior to the close of the second fishing season. In this phase, fishing effort is redirected to the three local areas depleted during Phase 2. During normal operations, vessels are allowed to search and fish in any manner consistent with other conservation measures that may have been set by the Commission (for example, size and gender limitations).

This experimental management scheme is intended to be flexible in that the strategy could accommodate a single-vessel fishery (that is, if only Golden Shamrock conducts crab fishing operations), but it would also benefit from the participation of multiple vessels because more information could be collected and interesting comparisons could be made between vessels simultaneously conducting different phases of the strategy.

Watters' proposed experimental fishery was well received at the WG-FSA meeting. Following the recommendation of the Scientific Committee, the Commission of CCAMLR adopted Watters' experimental fishing plan. (J. Rosenberg, [619] 546-5600)

MARINE MAMMAL DIVISION

La Jolla, California

Division Participates in International Conference

The Marine Mammal Division participated in the Tenth Biennial Conference on the Biology of Marine Mammals held November 11-16 in Galveston, Texas. The Biennial Conference, the premier meeting for marine mammal scientists and managers, allows scientists to exchange ideas with researchers from around the world. SWFSC Marine Mammal Division scientists made several presentations in specialized sessions and during poster presentations. In addition, Robert Brownell, chief of the Marine Mammal Division, chaired a session on research and conservation efforts on the vaquita; Steven Reilly, leader of the Dolphin Ecology Program, chaired a session on cetacean habitats; and Jay Barlow, leader of the Coastal Marine Mammal Program, co-chaired a session on international marine mammal policies. Presentations, which are listed under individual Marine Mammal Division program headings, are briefly described below. Abstracts for the entire conference are available through the conference sponsor, The Society for Marine Mammalogy, P.O. Box 368, Lawrence, Kansas 66044. (J. Sisson, [619] 546-7064)

DOLPHIN STOCK ASSESSMENT PROGRAM

Vaquita Population Monitoring Analyzed

Tim Gerrodette, leader of the Dolphin Stock Assessment Program, presented results of an analysis that he; Jay Barlow, leader of the Coastal Marine Mammal Program; Barbara Taylor, National Research Council Associate; and Greg Silber, Marine Mammal Commission, recently completed. From quantitative surveys conducted from July to November 1993 in the Gulf of California, Mexico, they estimate that the present size of the vaquita, *Phocoena sinus*, population is not more than a few hundred animals. The surveys have also confirmed that the present distribution of the vaquita is limited almost entirely to the northwest corner of the Gulf of California. Moreover, they show that ship and aerial surveys, no matter how carefully and thoroughly carried out, will be able to detect only large changes in vaquita population size; that is, statistical power is low. This conclusion has two important implications for conservation. First, small population size is, by itself, sufficient reason to institute protective measures for the vaquita; proof that the population is declining should not be required. Second, because it will be very difficult to determine whether population size is changing, a conservative approach, that is, protective measures, is required. (T. Gerrodette, [619] 546-7131)

Population Status Estimated for Northeastern Offshore Spotted and Eastern Spinner Dolphins

Since 1959, dolphins have been killed in the tuna purse seine fishery in the eastern tropical Pacific, with the majority being either from the northeastern stock of spotted dolphin, *Stenella attenuata*, or from the eastern stock of spinner dolphin, *Stenella longirostris orientalis*. NMFS recently proposed listing both stocks as depleted under the U.S. Marine Mammal Protection Act (MMPA). In a paper presented at the Tenth Bienniel Conference on the Biology of Marine Mammals, Scripps Institution of Oceanography graduate student Paul Wade explained that five NMFS research vessel surveys completed from 1986-90 provided data that he used

to calculate the current abundance of each stock. The calculations resulted in estimates of 730,900 for the northeastern spotted and 631,800 for the eastern spinner. The population status of both stocks was assessed by back calculating initial population size in 1959 from those current estimates of abundance. The eastern spinner dolphin was estimated to be at 44 percent of its level in 1959 while the northeastern spotted dolphin was found to be at 22 percent of its level that year. Both stocks are currently significantly below the maximum net productivity level, indicating that they are both depleted as defined by the MMPA. To improve upon the back-calculation technique, Wade developed a new method using Bayesian statistics to simultaneously estimate the rate of increase of a dolphin population and its initial population size by fitting a population model to available time-series-of-abundance data. A preliminary analysis resulted in an estimated rate of increase of less than 3 percent annually for the eastern spinner dolphin, with the current population level estimated to be at 31 percent of its initial population size in 1959. The eastern spinner dolphin has been formally listed as depleted by NMFS while a final ruling on the northeastern offshore spotted dolphin is expected soon. (P. Wade, [619] 546-7097)

COASTAL MARINE MAMMAL PROGRAM

Overview of Abundance and Distribution of Cetaceans off California

The California Current System is a highly variable coastal marine environment, with large interannual and seasonal variation. During 1991 and 1992, aerial and shipboard line transect surveys were conducted along the California coast to obtain information on the distribution and abundance of marine mammals. The surveys were designed to complement each other seasonally, with the aerial surveys conducted in winter/spring 1991 and 1992 and the shipboard survey conducted in summer/fall of 1991. Shipboard surveys conducted along the California coast during 1979-1980 provide a basis for historical comparison. Biologist Karin Forney presented the results of this analysis, which she completed along with Jay Barlow, leader of the Coastal Marine Mammal Program.

A total of 22 cetacean species were sighted on the 1991-1992 surveys, including one rare northern right whale, *Eubalaena glacialis*. Statistically significant (alpha=0.05) seasonal changes in abundance in the area studied were observed for Pacific white-sided dolphins, *Lagenorhynchus obliquidens*, and blue whales, *Balaenoptera musculus*. For Risso's dolphins, *Grampus griseus*, and northern right whale dolphins, *Lissodelphis peronnii*, smaller seasonal changes in abundance in this area are suggested. A seasonal shift in the distribution of northern right whale dolphins was also documented. The most abundant species during aerial and shipboard surveys was the common dolphin, *Delphinus delphis*. A historical comparison reveals that this species has increased considerably in abundance during the last 10 years. Furthermore, previous studies had indicated strong seasonal changes in distribution of common dolphins, but the two new abundance estimates from the aerial and shipboard surveys are remarkably similar. Blue whales also appear to have increased in abundance during the last decade. In contrast, the abundance of temperate delphinids (northern right whale dolphins and Pacific white sided dolphins) has apparently decreased, and short-finned pilot whales, *Globicephala macrorhynchus*, have virtually disappeared from California waters. (K. Forney, [619] 546-7171)

Humpback and Blue Whale Abundance Estimated along the U.S. West Coast

John Calambokidis, Cascadia Research Collective, has been working with scientists at the Southwest Fisheries Science Center (SWFSC) on the assessment of blue, *Balaenoptera musculus*, and humpback, *Megaptera novaengliae*, whales off the coast of California. He presented the results of an analysis he conducted with Gretchen Steiger, also from Cascadia, and Jay Barlow, leader of SWFSC's Coastal Marine Mammal Program. Estimates of abundance have been made for a number of cetacean species in recent years using mark-recapture statistics for whales having natural markings. However, critical examinations of these estimates have often revealed that failure to satisfy underlying assumptions about the mark-recapture procedures can severely bias the estimate. One of the most common assumptions is of heterogeneity of capture probability by nonrandom sampling. Calambokidis, Steiger, and Barlow's initial efforts to estimate humpback and blue whale abundance along the California coast were severely biased because this assumption was incorrect. Two critical aspects of their approach were to (1) clearly define the population or aggregation being estimated, and (2) obtain samples from this population that were representative and independent of each other. They were most successful in applying this approach to humpback whales. They determined that humpback whales feeding along the coast of California, Oregon, and Washington are part of a single

intermixing feeding aggregation having little interchange with other aggregations. They identified 265 and 399 unique whales in 1991 and 1992, respectively, from multiple areas within this region. Mark-recapture estimates that used a variety of samples yielded consistent abundance estimates of about 600 humpback whales. Estimates of blue whale abundance were more complex because defining the population was difficult. They identified an apparent offshore/inshore segregation of whales with limited interchange. A small sample of blue whales observed during line-transect surveys conducted systematically along the California coast, out to 300 nautical miles, provided the sample that was not biased with regard to geographic coverage of sampling efforts. (J. Barlow, [619] 546-7178)

Chlorinated Hydrocarbon Concentrations Found in the Gulf of California Harbor Porpoise

In addition to the assessment of large whales using photographic identification techniques, John Calambokidis, Cascadia Research Collective, has been working with researchers at the Southwest Fisheries Science Center on levels of pollutant concentrations in marine mammals. He presented the results of a paper coauthored with Lloyd Findley, Centro de Investigacion y Desarrollo de los Recursos Naturales de Sonora-Unidad Guaymas, Mexico, and with SWFSC's Robert Brownell, Marine Mammal chief, and Jay Barlow, leader of the Coastal Marine Mammal Program. High concentrations of chlorinated hydrocarbon contaminants have been noted in coastal odontocetes from different regions and have been linked to reproductive problems in a number of marine mammals. The Gulf of California harbor porpoise, *Phocoena sinus*, also known as the vaquita, is restricted to the northern waters of the Gulf of California, Mexico, and is considered one of the most endangered cetaceans. Blubber samples of eight vaquitas incidentally caught in gillnets were analyzed for chlorinated hydrocarbons. Relatively low concentrations of total DDT (530 to 9,100 parts per billion, wet weight), alpha-BHC (5 to 49 parts per billion, wet weight), and PCBs (40 to 200 parts per billion, wet weight) were found in the samples. Other chlorinated hydrocarbon pesticides were not detected. The DDT metabolite DDE was the only compound recovered from all vaquitas. Concentrations of total DDT compounds suggested an accumulation with age in males and a declining concentration in females after reproductive maturity though the sample size was too small to statistically test these associations. The proportion of DDE to total DDT indicates that the source of the DDT compound is not from recent applications of DDT. Based on the low concentrations of chlorinated hydrocarbon pesticides and PCBs found, these contaminates do not appear to pose an immediate hazard to the species. (R. Brownell, [619] 546-7165)

POPULATION IDENTITY PROGRAM—BIOLOGICAL ASSESSMENT

Individual-based Model Predicts Biological Indicators for Delphinid Populations

Regulatory mechanisms for populations of delphinids were investigated with a model that keeps track of the age and reproductive condition of individual animals. Douglas DeMaster, National Marine Mammal Laboratory, presented the results of a paper he coauthored with Fishery Biologist Susan Chivers, Southwest Fisheries Science Center. DeMaster and Chivers predicted correlations between population density and (1) the proportion of sexually mature females in the population, and (2) the average age of sexual maturity on the basis of a qualitative population model that assumes population growth is primarily regulated by juvenile survival, pregnancy, and maturation rates. Linear and non-linear density dependence were incorporated in the model; the shape parameter (z) for the generalized logistic population growth equation ranged from 1.0 to 12.0. They found that (1) the proportion of mature females in the population and (2) the average age at attainment of sexual maturity were positively correlated with population density when $z=1.0$ or $z=2.4$ for the pregnancy rate and maturation rate functions. The shape of the production curve could not be predicted from the functional relationship between the regulatory parameter and density. In fact, for all forms of density dependence, the maximum net productivity level relative to carrying capacity ranged from 0.57 to 0.85. Finally, they concluded that it is likely that multiple density-dependent parameters regulate population growth. (S. Chivers, [619] 546-7093)

Prey Occurrence Studied in Spotted Dolphins from the Eastern Tropical Pacific

Biologist Kelly Peltier presented the results of a study she and Fishery Biologist Susan Chivers initiated. In the study, prey items were examined from 428 eastern tropical Pacific spotted dolphin, *Stenella attenuata*, stomachs. Fifty-three species of fish and 38 species of cephalopods were identified, using

fish otoliths and cephalopod beaks. The most frequently occurring species of fish were from the family Myctophidae, which occurred in 49 percent of the stomachs and represented 75 percent of the fish by number. The most frequently occurring species of cephalopods were from the family Ommastrephidae (squids), which occurred in 65 percent of the stomachs and represented 28 percent of the cephalopods by number. These species of fish and cephalopods are associated with the deep scattering layer. These results differ from the prey in yellowfin tuna, *Thunnus albacares*, stomachs, in which 42 percent of the cephalopod composition consisted of octopus from the family Argonautidae, a species found in near-surface waters. The dolphin sample was stratified by geographic area and oceanographic season, and a significant difference was found to occur in the number, occurrence, and proportions of both fish and cephalopods across all areas and by season. A significant difference was also found in the time of day the dolphins were feeding. More full stomachs were found in the morning hours while no full stomachs were found later in the afternoon, suggesting that the dolphins are feeding at night when prey from the deep scattering layer migrates upward. (K. Peltier, [619] 546-7182)

POPULATION IDENTITY PROGRAM—PHOTOGRAMMETRY

Central American Spinner Dolphin Morphology and Life History Data Taken from Vertical Aerial Photographs

Fishery Biologist Wayne Perryman and Wildlife Biologist Robin Westlake presented the results of a study using dolphin lengths measured from aerial photographs to examine the morphology and reproductive season for the Central American spinner dolphins, *Stenella longirostris centroamericana*. Few data are available for this species because they are not significantly impacted by fisheries. This spinner dolphin ranges along the Continental Shelf from south of the Gulf of Tehuantepec to Panama. Using a stereo comparator, they measured the lengths of 1,600 Central American spinner dolphins from four schools that were photographed in August 1992 off the coast of Guatemala. For females, sex was inferred by the close association of a calf. Asymptotic length for males and females was estimated to be 229 centimeters and 218 centimeters, respectively. The average adult length for females was 198 centimeters (range 172-219 cm). Calves aged less than 1 year comprised 8.2 percent of the sample. The back-projected birth dates indicate a single spring reproductive pulse. (W. Perryman, [619] 546-7014; R. Westlake, [619] 546-7001)

Photographic and Ground Counts Compared for Steller Sea Lions at Año Nuevo Island

Wildlife Biologist Robin Westlake presented the results of Steller sea lion assessment methods that she, Fishery Biologist Wayne Perryman, and University of California Santa Cruz Biologist Kathryn Ono initiated in 1990. Aerial photographic and ground surveys of Steller sea lion rookeries were conducted within one day of each other at Año Nuevo Island during the breeding seasons of 1990-1992 to evaluate the effectiveness of these two sampling techniques for monitoring changes in this population. No significant trend was detected in the ground counts of pups. Rates of decline determined from counts of non-pups were not significantly different, but both differed from the rate determined from photo counts of pups. In addition, three replicate surveys were conducted during 1992 to estimate the variance associated with each sampling technique. Regressions fit to the $\log_n$ transformed counts versus year (1990-1992) for pup and non-pup photo counts, and non-pup ground counts revealed significant declining trends of -0.087, -0.459, and -0.351, respectively. Using the coefficients of variation from the replicate surveys and setting alpha=0.05 and beta=0.10, the biologists determined that a 4-percent annual change in numbers of pups or nonpups could be detected with a series of three annual photographic surveys. Ground counts of pups were the most variable of methods, and the minimum annual change detectable was 18 percent. (R. Westlake, [619] 546-7001)

Military Thermal Sensor Used to Determine Migrating Gray Whale Nighttime Travel Rates

David Withrow and K. Shelden, National Marine Mammal Laboratory, and Fishery Biologist Wayne Perryman, Southwest Fisheries Science Center, presented the results of their study designed to determine the night migration rate of gray whales relative to the rate observed during the day. The night migration rate has long been a key concern for estimating population parameters. Extrapolation of whale movements for periods of nonwatch (night) contributes significantly to the uncertainty of an abundance estimate. Past studies have used radio tags, starlight scope and infrared night vision technology, and statistical corrections during predawn and late evening watches. Previous night

vision experiments suffered from use of equipment that was not sophisticated enough to detect small, faint targets. In light of the military's recent efforts to transfer technology to civilian use, Withrow, Sheldon, and Perryman approached the U.S. Army about the availability of equipment that could allow detection of the temperature difference between the exhalation of a gray whale and its surrounding environment. The Navy loaned them an AN/TAS-6 passive infrared imaging system, designed to detect and display temperature differences of 0.20 degrees centigrade. The instrument was modified to allow the optical display to be recorded on standard video tape. They used the wide field of view which allowed them to record information from the horizon to about 420 meters away from the sensor. Tests of the system were run in mid-January, when peak numbers of gray whales were migrating past the census station near Carmel, California. Preliminary results show that the whale blows were easily detectable, equally visible during the day and at night, and that roughly equal numbers of pods (15 pods per hour) passed during the day and at night. The whales appeared to be moving at the same distance offshore both day and night. With further testing, this new technique may well prove to be an invaluable tool for nighttime observations of marine mammals. (W. Perryman, [619] 546-7014)

POPULATION IDENTITY PROGRAM — GENETICS

Genetic Variation Studied Within and Among Populations of Bottlenose dolphins

Barbara Curry, a graduate student from Texas A&M University, has been working with the scientists at the Southwest Fisheries Science Center on differentiation between stocks of bottlenose dolphins. Her poster presentation on this subject, coauthored with Andrew Dizon, leader of the Population Identity Program, won first place in the Graduate Student Category.

Geographic variation in small cetaceans is often extreme, even over short distances, and phylogenetic relationships among bottlenose dolphin populations with both allopatric and sympatric distributions are unclear. Inshore and offshore forms of bottlenose dolphins are commonly recognized based on morphological and ecological evidence, and some investigators postulate the existence of multiple local populations inshore. Direct sequencing of the control region of mitochondrial DNA was used to examine population structure in bottlenose dolphins from the eastern North Pacific, western North Atlantic and Gulf of Mexico, and Indian Oceans. Total genomic DNA was isolated from tissue samples of approximately 40 individuals representing animals from different ocean basins and inshore/offshore forms. A portion of the mitochondrial DNA control region was amplified using polymerase chain reaction procedures and dideoxy sequencing techniques. Genetic divergence was examined, hypothesizing geographic concordance with greater differences between individuals having allopatric distributions. (B. Curry, [619] 546-7094)

Intraspecific Population Structure of the Beluga Whale Studied

Greg O'Corry-Crow, National Research Council Fellow, presented the results of the work he; Janet Ziegle, Applied Bioscience; and Population Identity Program Leader Andrew Dizon, Southwest Fisheries Science Center, initiated to study the intraspecific differences among beluga whale, *Delphinapterus leucas*, populations. Three molecular techniques offering different orders of resolution are being used in a comprehensive genetic investigation of the intraspecific structure of the beluga whale in Alaskan and northwest Canadian waters. The three methods under study are (1) the direct sequencing of a region of the mtDNA genome, (2) rapid detection of DNA polymorphisms using arbitrarily primed polymerase chain reaction (termed RAPD PCR), and (3) development of a novel approach for genotyping highly polymorphic microsatellite DNAs.

To date, total cellular DNA has been extracted from 53 individuals collected from a number of locations, representing from 2 to 5 commonly accepted populations in Alaskan and northwest Canadian waters. Initial results from sequencing the control region of mtDNA have not, as yet, revealed geographically concordant structuring. However, optimal reaction conditions have been determined for several RAPD primers. A number of polymorphisms have been detected among individuals both within and between suspected populations. Preliminary analysis has detected frequency differences in some polymorphic DNAs between areas. The microsatellite technique under development essentially involves the use of the PCR with hybridization-probe technology to identify polymorphic loci, coupled with fluorescent tagging and high resolution polyacrylamide gel electrophoresis (PAGE) to distinguish variant alleles, which often differ by as little as a few base pairs. Fluorescent labeling of PCR products used in conjunction with GENESCAN software enables automatic and un-

ambiguous screening of several independent loci simultaneously. The approach has several advantages over existing, more labor-intensive and less-accurate techniques. Microsatellite-containing sequences have been successfully identified and amplified. O'Corry-Crow and Dizon are at present labeling the repeat DNAs and screening for polymorphisms. (G. O'Corry-Crow, [619] 546-7091)

Intraspecific Population Structure Studied of the Northern Right Whale Dolphin

Population Identity Program Leader Andrew Dizon presented the results of a study he, Biologist Carrie LeDuc, and Scripps Institution of Oceanography graduate student Richard LeDuc initiated in order to obtain quantitative measures of reproductive isolation between population centers of the fishery-impacted northern right whale dolphin, *Lissodelphis borealis*. A portion of the control region of the mitochondrial DNA (mtDNA) genome was sequenced in 63 geographically dispersed individuals, then analyzed in a nested ANOVA (analysis of variance) format. No evidence of geographically concordant population structuring was apparent when the sample population was stratified into two offshore populations (west and east of the international dateline) and one inshore population (California coastal). In addition, a Mantel test, examining pair-wise correspondence between geographic and genetic distances among samples, failed to detect any evidence of isolation by distance. A power analysis conducted to determine the probability that a comparably sized survey (in terms of numbers of samples and numbers of base pairs sequenced) would yield statistically significant evidence of segregation revealed a power of about 50 percent for detecting differences among closely related populations. This suggests caution in accepting the null hypothesis of a single, panmictic stock for the northern right whale dolphin. (A. Dizon, [619] 546-7089)

Mitochondrial DNA Genetic Variation Studied Within and Among Populations of Eastern Tropical Pacific Spinner Dolphins

Scripps Institution of Oceanography graduate student Angela Garcia and Population Identity Program Leader Andrew Dizon presented their results on the genetic variation in spinner dolphins, *Stenella* spp., from the eastern tropical Pacific Ocean, using sequences from the D-loop region of mtDNA. Total DNA was extracted from liver tissue following standard protocols, enzymatically amplified by the polymerize chain reaction, and sequenced using dideoxy sequencing methods. Forty-three samples were analyzed. Pair-wise genetic relatedness among and within populations were examined using AMOVA, a public-domain computer program designed to study DNA divergence in an analysis of variance format. Individuals were stratified based on (1) a morphotype index defined by color pattern and dorsal fin shape; (2) the appearance of the majority of the adult dolphins within a school, that is, as whitebelly or eastern spinner dolphin stocks as identified by observers on fishing boats; and (3) school membership; that is, each was treated as a separate population. Preliminary results indicate that the stratification based on school affiliation is the only one that is statistically significant—individuals are significantly more closely related to others within the same school than they are to others outside their schools. (A. Dizon, [619] 546-7089)

Evolutionary Relationships Analyzed Among Delphinine Dolphins Using Mitochondrial DNA Sequence Data

Scripps Institution of Oceanography graduate student Richard LeDuc presented preliminary results of an investigation he and Population Identity Program Leader Andrew Dizon initiated on the phylogenetic relationships among dolphins of the subfamily Delphininae (family: Delphinidae) using genetic data. Species in the genera *Stenella* (five species), *Delphinus*, *Tursiops*, and *Lagenodelphis* were included in the analysis as well as nondelphinine dolphin species used for outgroups. Genomic DNA was extracted using phenol-chloroform and the target sequence of mtDNA was amplified by the polymerase chain reaction using conserved primers. Sequences from the cytochrome-B gene and the control region were obtained by dideoxy sequencing methods. Phylogenetic inferences were made based on the sequences, primarily using parsimony analysis (which infers relationships requiring the least number of evolutionary steps to explain data set differences), and these were compared to relationships implied by accepted dolphin taxonomy. Preliminary analysis of data from the first three genera listed indicated that the various species of *Stenella* have close affinities to the other delphinids and that the monophyly of the genus may be open to question. (R. LeDuc, [619] 546-7095)

DOLPHIN ECOLOGY PROGRAM

Cetacean Habitats in the California Current Analyzed

Paul Fiedler, oceanographer, presented the results of an analysis he conducted with Dolphin Ecology Program Leader Steve Reilly, Coastal

Marine Mammal Program Leader Jay Barlow, and Biologist Karin Forney. Cetacean abundances and oceanographic conditions were sampled during a 3-month ship survey on the 53-m NOAA research vessel *McArthur* within the California Current between the Mexican and Oregon borders, July 28 - November 5, 1991. They used canonical correspondence analysis (CCA) to investigate cetacean habitat use and community composition. CCA is an eigenvector ordination technique that fits a non-linear species response to environmental axes that are linear combinations of observed variables. Environmental variables included in the analysis were surface temperature, salinity, and chlorophyll; integrated primary productivity; mixed layer depth; 14-degree Celsius isotherm depth; variables representing temperature and salinity gradients; plus alongshore and offshore distance to represent fixed geographic effects. The first four axes of the ordination were significant, explaining 91 percent of the covariability of 20 species and 11 environmental variables at 66 sites (days of effort). The dominant pattern (first axis) separated harbor and Dall's porpoises, Pacific whitesided dolphins, and killer whales in cold, northern water from offshore bottlenose dolphins in warmer, southern water. The second axis also separated longbeaked common dolphins and humpback whales in productive nearshore waters from striped dolphins and sperm whales in unproductive offshore waters. The third axis defined a high-salinity, southern, somewhat offshore habitat occupied by baleen whales (blue, fin, humpback, minke, and Bryde's). The first three axes cumulatively explained 28 percent of the variance in cetacean abundance. For individual species, this ranged over 50 percent for longbeaked common dolphins and Dall's porpoise to less than 10 percent for the less common baleen and beaked whales. Canonical correspondence analysis quantifies patterns of habitat variability in a way that can explain changes in the distribution of species and thus reduce error in abundance estimates. (P. Fiedler, [619] 546-7016)

DOLPHIN SAFE PROGRAM

Spotted Dolphins Associated with Tuna Radiotracked in the Eastern Tropical Pacific

Michael Scott, biologist from the Inter-American Tropical Tuna Commission (IATTC), presented results that he; Biologist Susan Chivers, Southwest Fisheries Science Center; and Robert Olsen and Richard Lindsay, IATTC, obtained from the first Dolphin-safe research cruise. As part of a study of the tuna-dolphin bond, six spotted dolphins, initially found in association with yellowfin tuna, were radiotracked in the eastern Pacific Ocean during November 1992: The dolphins were tracked over a period of a week, which provided data on their movements, surfacing times, and dive profiles. They traveled both day and night, covering about 60 miles per day. Three dolphins also carried time-depth recorders (TDRs); two TDRs were recovered when the dolphins were recaptured after 1-2 days at liberty. The TDR data showed distinct day-night differences in diving patterns. The spotted dolphins, *Stenella* spp., swam within the mixed layer during the daytime, often at a depth of 10-20 meters, but dove well below the thermocline at night. At dawn and dusk, both dolphins appeared to feed at depth, making dives to 50-100 meters that lasted up to 4.7 minutes each. Their diving patterns suggested that the dolphins were feeding at night on organisms associated with the deep scattering layer. Repetitive sets on the same dolphins also allowed the scientists to examine the short-term herd integrity and association with yellowfin tuna. (S. Chivers, [619] 546-7093)

NATIONAL RESEARCH COUNCIL FELLOW

Population Viability Analysis Model Developed Using Steller Sea Lion Data

Population viability analysis (PVA) assesses the probability of extinction of a species in a given time period. PVA is proposed as a criterion to classify species according to extinction risk. To investigate the precision and bias in PVA and to assess the two classification schemes proposed for the International Union for Conservation of Nature (IUCN) red data book, Barbara Taylor, National Research Council Associate, and Ann York, National Marine Mammal Laboratory, created a model based on the recovery plan for Steller sea lions. Thirty simulations were run of the model which incorporated demographic and environmental stochasticity. These simulations generate the true distribution of extinction times. Data of the quantity and quality actually available for the species were sampled from the simulations. A PVA, where parameters had to be estimated, was then performed on each sample data set. The PVA simulations generate the estimated distribution of extinction times. Growth rates were positively biased, resulting in extinction rates in 100 years ranging from 12 to 89 percent (mean=50 percent) estimated from PVA, compared to 64 to 82 percent (mean=76 percent) from the model. The Mace and Lande classification scheme (published in 1991) placed 28 PVA simulations as

endangered and 2 as vulnerable, all based on PVA, while the IUCN scheme placed all 30 as endangered, all based on estimated trends in abundance. (B. Taylor, [619] 546-7097)

HONOLULU LABORATORY

Honolulu, Hawaii

PROTECTED SPECIES INVESTIGATION

Preliminary Results Presented for 1993 Northwestern Hawaiian Islands Hawaiian Monk Seal Field Season

During 1993, long-term field camps were established at four of the five main breeding islands of the Hawaiian monk seal, *Monachus schauinslandi*. Primary activities at the camps involving Honolulu scientists included pup tagging, population monitoring, collecting, rehabilitating and releasing seals, studying the mobbing problem, collecting scats for prey species determination, and continuing the foraging pattern pilot project with attachment of satellite-linked time-depth recorders. The primary indicators of the status of these main populations are number of pups born (Fig. 1) and the mean beach counts. As illustrated in Figure 1, the number of pups born in 1993 was approximately 190, well above the number born in 1990 in spite of the fact that only 88 pups were born at French Frigate Shoals. Brief highlights of field activities are provided below.

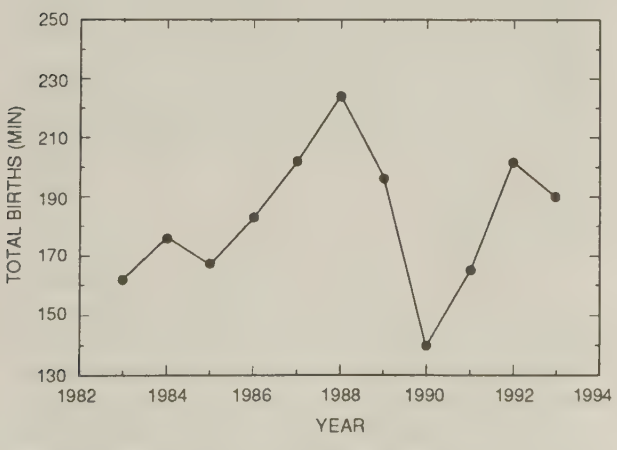

Figure 1. Minimum number of Hawaiian monk seal births in the Northwestern Hawaiian Islands, 1983-93.

Kure Atoll

Under the supervision of Fishery Biologist John Henderson, field activities commenced on April 19 with a 3-day visit to the atoll aboard the NOAA ship *Townsend Cromwell*. Beach censuses were conducted, and seven yearling seals that had been rehabilitated on Oahu were released. A long-term camp was established on July 11; the field party and three yearling seals arrived via the U.S. Coast Guard Cutter *Sassafras*. The seals were released into the wild population and monitored for the remainder of the field season. Other activities included conducting censuses, tagging pups, resighting tagged seals, removing any beach debris that presented a threat of entanglement to wildlife, and monitoring the seal population for injuries and deaths. Field biologists also briefed several groups of contractors to minimize disturbance to seals and other wildlife. The camp was disbanded on August 25. Another four yearling seals were flown to Kure for release on September 14.

Fifteen atoll-wide censuses were conducted, with an overall mean count of 32.1 seals, including pups. Births of 13 seals were confirmed and all 13 pups were tagged. No deaths were observed. One weaned pup became entangled in a scrap of fishing net but freed itself within a day. Approximately 900 items of potentially entangling debris weighing an estimated 1,950 kg were inventoried, removed from beaches, and destroyed. Of the 10 yearling seals translocated to Kure early in the field season, 7 were resighted during the summer.

Midway Islands

Field activity at Midway Atoll commenced on January 7, 1993, with the release of three immature female seals. One of these animals was subsequently found dead on March 6 and the other two were not resighted.

Field observations continued from April 15 to 19 and May 20 to July 1 under the direction of Tanya Holonko, volunteer from the Colorado State University School of Veterinary Medicine. Of the 20 seals released at Midway in 1992-93, only 2 were resighted alive during these spring/summer observations. Two pups were born, one disappeared, and the other was weaned and subsequently tagged. No injuries or entanglements were noted.

Pearl and Hermes Reef

Short-term field camps were established on Southeast and North Islands at Pearl and Hermes

Reef during April 18-22 and June 27-30. Four atoll-wide beach censuses showed a mean count of 71.5 animals, including pups. Twenty-one weaned pups were tagged, including 7 females and 14 males. No serious injuries or entanglements were observed, and no deaths were documented. During each visit, all potentially entangling marine debris on the islands was cataloged and destroyed.

Lisianski Island

Field studies were conducted from April 17 to June 26 under the camp leadership of Biological Technician Heather Johnston. Mean beach counts and known births were slightly lower than in 1992. The mean beach count, including pups, was 71.8 (compared with 83.0 in 1992). Seventeen births were recorded (compared with 23 in 1992). The male-to-female sex ratio in the mature age class was 1.7:1.0, significantly lower than in 1992 (2.0:1.0). No mortalities were observed. Eight seals with mating- or mobbing-related injuries were seen. Two entanglements were observed; in both cases, the entangling debris was removed from the animals.

Laysan Island

A field camp was established during April 16-June 25 and on August 2, under the supervision of Karen Lombard, cooperating scientist, Joint Institute for Marine and Atmospheric Research. The mean of 10 beach counts in 1993 (including pups) was 99.5 seals, which is similar to the past few years. The total number of animals in the population (excluding pups) was 204, 20 fewer than 1992. This decline was mostly due to a loss of males, particularly adults, thus lowering the adult male-to-female sex ratio from 1.4:1.0 in 1992 to 1.3:1.0 in 1993. Forty-two births were documented, the second highest number of births recorded since 1977. Forty-one of the pups survived to weaning and all but four were tagged. As part of the immature growth study, 71 weaned pups and juveniles were weighed and measured. Three mortalities, none of which were attributed to mobbing, were documented at Laysan Island. Two separate mobbing incidents involving the same adult female were observed and resulted in minor injuries to the seal. One other mobbing injury was seen on an immature 3-year-old female. One entanglement of an adult female was observed, and the animal disentangled herself. All potentially entangling marine debris was inventoried and destroyed.

On March 26, United States Fish and Wildlife Service (USF&WS) personnel reported oil contamination affecting most of the coastline. Tar balls and large clumps of oil were observed. Fifteen seals were oiled, five of them heavily matted. USF&WS personnel raked up the oil and burned it; by April 16 no oil was apparent on the beaches. All oiled seals were observed to be unaffected later in the season.

French Frigate Shoals

A field camp was established during January 9-February 6 under the direction of Mitchell Craig, wildlife biologist, and from April 25 to September 27 with Lisa Hiruki, wildlife biologist, as camp leader. The mean spring-summer beach count for 1993 (including pups) was 188.1 seals, approximately 30 less than for 1992. The 89 births this year were 13 less than in 1992. Of 76 pups that survived to weaning, 74 were tagged. Four pups were still nursing as of September 16. Nine seals were found dead, four of which were prematurely weaned pups or stillbirths. During January, 29 yearlings and 7 2-year-olds were weighed and measured. During April through September 16, 102 weaned pups and juveniles were weighed and measured as part of the immature seal growth study. One seal was released from entangling marine debris. Three male seals were instrumented with satellite transmitters in September.

Rehabilitations and Reintroductions. All seals collected for rehabilitation were from French Frigate Shoals (FFS). Three 2-year-old seals collected in 1992 were released at Midway Atoll on January 7. Fourteen yearling seals, collected in 1992 and early 1993, were released at Kure Atoll between April and September.

Eight female pups are currently being rehabilitated at Sea Life Park and the NMFS Kewalo Research Facility. Three small seals collected during 1993 died soon after collection: one injured and emaciated juvenile died while being maintained at FFS, one succumbed to pneumonia at Sea Life Park, and one died of renal failure at the NMFS facility.

Necker Island

Field observations were conducted at Necker Island on April 26 and during July 30 - August 5 by Lt.(jg.) Michele Finn, NOAA Corps officer. The mean of 6 beach counts was 22.8 seals (including pups), which was lower than in previous years (mean of 32.9 for 1983-88). Only one weaned female pup was observed and tagged. Four adult female seals with fresh mobbing injuries were observed. Fifteen seals that were born and tagged at FFS were

seen at Necker Island. No mortalities or entanglements of seals were observed.

Nihoa Island

The Hawaiian monk seal population at Nihoa Island was studied from July 29 to August 7, 1993, by Fishery Biologist Tim Ragen. The primary objective was to determine if immature seals were migrating from French Frigate Shoals to Nihoa, thereby providing at least a partial explanation for the recent decline at French Frigate Shoals. A total of eight seals were seen with FFS tags, but all these seals were subadults or adults; hence, migration to Nihoa Island does not appear to have contributed to the decline at French Frigate Shoals.

Seven censuses were conducted; the mean count was 21 seals, which included 2 nursing pups and 1 weaned pup. The majority of the seals observed during this 10-day camp were adults. In general, the sex ratio of seals on the beach was approximately 1:1. Two adult females were observed with older, healed mobbing scars. (W. Gilmartin, [808] 943-1239)

Hawaiian Monk Seals at French Frigate Shoals Continue to Decline

From the late 1950s to the late 1970s, the total population of Hawaiian monk seals declined by approximately 50 percent. However, the decline occurred primarily in the western populations and, contrary to the overall trend, the monk seal population at French Frigate Shoals increased as much as sixfold. At this site, seals increased to their highest numbers in the mid-1980s but then began to decline sharply during 1989-90. Virtually all monk seal populations experienced a marked drop in birth rate and juvenile survival in 1990, suggesting that the cause may have been a large-scale environmental phenomenon. However, while other populations exhibited at least partial recovery in 1991, the French Frigate Shoals population continued to experience low birth rate, low total number of births, small weaning size of pups, and poor juvenile survival. These demographic changes persisted in 1992 and were evident again in 1993.

The observed changes suggest that conditions at this site are severe for all age classes. Juvenile growth and survival remain low, with many immature seals in poor or emaciated condition. However, the decline in birth rate and in the average weaning size of pups suggests that adult females are also compromised. These changes, combined with the rehabilitation and translocation of some immature females, have altered the age structure of seals at this site; that is, the number of juvenile females is lower than would be expected under stable conditions. Consequently, even with stabilization of the population, the number of pups born is again expected to decline as the affected age classes reach maturity and are recruited into the reproductive portion of the population.

The ultimate cause(s) of the decline has not been identified with certainty, but all evidence gathered to date suggests that available prey is not sufficient to support the number of seals at this site. The apparent decline in availability of prey may be related to oceanographic changes, as suggested by Polovina and others (in press), or may simply indicate overutilization of prey resources subsequent to the increase in seals over the previous four decades. The role of potentially competing fisheries, such as the Northwestern Hawaiian Islands lobster fishery, is unknown.

Management's response to the decline has been outlined in a research and management plan for this population (report in progress). Among other things, the plan focuses on continued monitoring of the status of these seals, together with rehabilitation and relocation of compromised immature females and greater efforts to investigate the foraging ecology of the species. The study of their foraging ecology has already begun, with analysis of scat and spew collections, monitoring of selected adult and subadult seals instrumented with satellite-linked time-depth recorders, and, importantly, with cooperative efforts such as the recent assessment of temporal changes in reef fish abundance conducted by the Insular Resources Investigation of the Honolulu Laboratory in Administrative Report H-93-06. (T. Ragen, [808] 943-1280)

Laboratory Participates in Teacher at Sea Program

The Honolulu Laboratory, in conjunction with the NOAA ship *Townsend Cromwell*, participated in the Teacher at Sea Program which is sponsored by the NOAA Education Office, Seattle, Washington. Between April and September 1993, 11 teachers from the mainland and Hawaii joined NMFS personnel in a range of activities that included supporting Protected Species Investigation field camps on Nihoa and Necker Islands and participating in the stock assessment of spiny lobster, Panulirus marginatus; slipper lobster, Scyllarides squammosus; yellowfin tuna, Thunnus albacares; and opakapaka (pink snapper), Pristipomoides filamentosus, in waters surrounding the Northwestern

Hawaiian Islands. In every case, the teachers were enthusiastic and integrated well with NMFS employees. Both NMFS field personnel and the officers of the NOAA Ship *Townsend Cromwell* believe that the Teacher at Sea Program was extremely successful this year and should be continued in the future. (M. Finn, [808] 943-1271)

INSULAR RESOURCES INVESTIGATION

Baited Video Cameras Reassessed as Sampling Tool for Juvenile Opakapaka

Research on juveniles of the pink snapper or opakapaka, *Pristipomoides filamentosus*, an economically important species that comprises large fractions of deep-reef bottomfish catches in Hawaii, is a continuing focus of the Honolulu Laboratory's Insular Habitat Program. On a September 1993 cruise of the NOAA ship *Townsend Cromwell*, baited video cameras were again evaluated as samplers to assess the abundance of juvenile opakapaka. (The bait holder was attached to the arm extending from the camera. Mackerel was used inside the holder, with a squid tied to the outside.) On Leg I of the cruise (September 3-12), operations were repeated off Kaneohe Bay, windward Oahu (Southwest Fisheries Science Center Report of Activities, March-April 1993), and off South Molokai, both in the main Hawaiian Islands. On Leg II (September 14-29), exploratory surveys were extended off windward French Frigate Shoals (FFS) in the Northwestern Hawaiian Islands. On both legs, the video systems were deployed from auxiliary craft (5-m [17-ft] Boston Whalers).

On Leg I, a total of 108 standardized (10-minute) camera drops were attempted over 41- and 46-fathom deep, unconsolidated seabeds, in areas of known abundance of young-of-the-year and I+ (ages 1-2 years) juvenile opakapaka. There were two camera drops at each of the two stations—one was a shallow drop, the other a deep drop. They ran the camera for 10 minutes at the deeper drop. If they were successful in filming any fish and were, therefore, able to count them, then they considered the drop to be quantitative. One hundred-and-five of the 108 drops were quantitative: 54 were taken off Kaneohe Bay and 51 off South Molokai. Juvenile opakapaka were abundant on these videos, especially at 46 fathoms, but seemed more patchily distributed than on prior video surveys (see below). Fifty-four camera drops (53 quantitative) were completed at depths of 41 and 46 fathoms off windward FFS on Leg II of the cruise. Juvenile opakapaka were rarely encountered, and bottomfish in general were not abundant on the FFS videos.

A major objective of these pending video analyses will be to extend preliminary estimates of the precision of video abundance indices, first characterized on *Townsend Cromwell* cruise TC-92-04 in May 1992 and recently reassessed several months prior to cruise TC-93-06. Preliminary estimates of statistical power based on TC-92-04 data had suggested that about 2 or 3 days of effort would be sufficient to detect year-to-year temporal changes of about 50 percent in video indices of juvenile opakapaka. In May 1993, Insular Resources Investigation personnel completed a 3-day, shore-based survey out of Kaneohe Bay using small craft that again indexed juvenile abundance using the same video camera systems. Results of the latter survey generally confirmed that about 3 days effort by two small craft would provide power sufficient to detect halvings or doublings in juvenile abundance, at least during May. The apparently greater variances of September data (between the shallow and deep camera drops), if real, may reflect temporal (perhaps seasonal) effects that influence the power of temporal comparisons. Video sampling of juvenile opakapaka may have to be restricted to certain times of the year to obtain acceptable levels of precision.

A manuscript recently submitted to *Fishery Bulletin* by Fishery Technician Denise Ellis and Insular Ecology Leader Edward DeMartini compares the species composition and relative efficiencies of video and epibenthic longline samplers. The manuscript also provides statistical power and sample size estimates for indexing juvenile opakapaka abundances, based on May 1992 and May 1993 data. (E. DeMartini, [808] 943-1266; D. Ellis, [808] 943-1254)

DATA MANAGEMENT AND TECHNICAL SERVICES

Oracle Training Conducted at Honolulu Laboratory

Several key data management and systems personnel of the Honolulu Laboratory recently completed training classes in Oracle Data Base Design and System Administration. These courses were provided by IT-95 funding to implement the design and conversion of the Honolulu Laboratory's data bases. (D. Tieman, [808] 943-1251)

PELAGIC FISHERIES RESOURCES DIVISION

La Jolla, California

STOCK ASSESSMENT AND FISHERY IMPACT ANALYSIS PROGRAM

Observers Return from 1993 Albacore Troll Season with Catch and Gillnet Injury Data

The Pelagic Fisheries Resources Division (PFRD) has, for the last four seasons, placed biological technicians on U.S. albacore troll vessels to obtain catch and length-frequency data and to examine the catch for injuries (or marks) indicating previous encounters with foreign high-seas driftnets. Samples were taken from within the traditional U.S. albacore troll fishing grounds in the northeastern Pacific.

Biological Technicians Eric Forney, Chris Fanning, and John Childers departed from Honolulu aboard U.S. albacore troll vessels during the first week of June 1993 while Gary Rensink departed from Newport, Oregon, during the third week of June. They all returned by the second week of September. Their objectives included measuring and examining as many of the albacore landed each fishing day as was possible.

Fishing on the vessels was generally poor to fair, with a few very good days, throughout the North Pacific Transition Zone and coastal areas. Highest numbers were taken west of 140° W longitude. A total of 10,738 albacore were examined for net marks and measured for both fork length and maximum girth during the 275 fishing days observed this season. The 1993 length-frequency distribution indicates the presence of 2-, 3-, and 4-year old albacore, more typical of the 1990 and 1991 data than the 1992. The strong 3-year-old age class of 1992 may have been influenced by El Niño conditions (Fig. 1).

Of the catch observed, only 0.31 percent showed signs of previous interaction with driftnets, down from 3.1 percent last year and a high of 12.4 percent in 1990. This is the first fishing season after the 1992 United Nations ban on all high seas drift gillnet fishing in the North Pacific. While this low incidence of marked fish is encouraging, it is too early to speculate that the ban is responsible since effort data from the high seas driftnet vessels is not yet available.

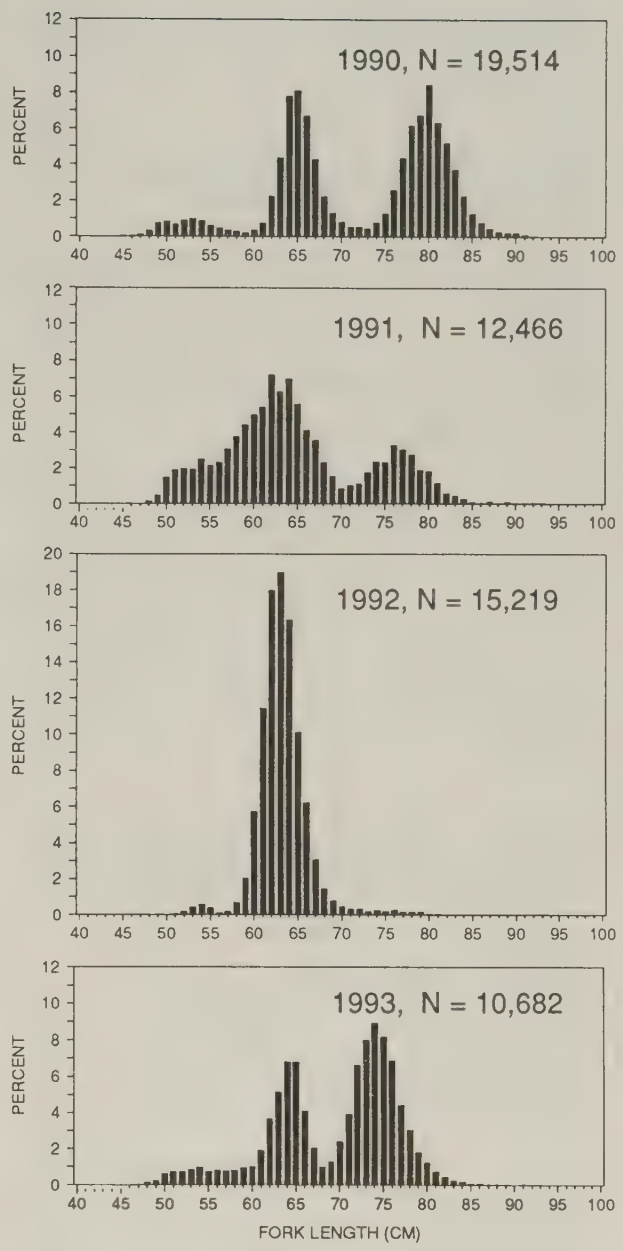

Figure 1. Length-frequency distributions of albacore sampled from U.S. troll vessels within the traditional U.S. albacore troll fishing grounds in the northeastern Pacific from 1990 to 1993.

The technicians also collected 300 albacore heads during their cruises to use for studies of age. One otolith, the opercal plate (gill cover), two vertebra, the first dorsal fin spine, and an anal fin ray from each fish were collected and sent to Margarita Margolles at Centro de Investigation Cientifica y de Educacion Superior de Ensenada (CICESE) in

Ensenada, Mexico, for ageing studies while the second otolith from each fish was sent to Fishery Biologist Keith Bigelow at the Honolulu Laboratory for confirmation analysis. (D. Holts, [619] 546-7186)

Second Shark Abundance and Tagging Cruise Completed With California Department of Fish and Game

The Pelagic Fisheries Resources Division and the California Department of Fish and Game (CDF&G) conducted their second experiment to develop and evaluate a catch-per-unit effort (CPUE) index for pelagic sharks in the waters off southern California. Fishery Biologists Darlene Ramon and Dave Holts participated in the September cruise aboard the CDF&G research vessel *Mako*. Ten sets were conducted, using stainless steel longline gear. Total effort was 1,102 hooks deployed, which varied between 80 and 173 per set depending on sea state, water temperature, and time of day. CPUE (catch per 100 hooks) was 3.1 shortfin mako shark, 4.2 blue shark, 1.0 pelagic ray, and 0.0 thresher shark. CPUE on the first cruise conducted in the same area in May aboard the NOAA ship *David Starr Jordan* was 0.1, 12.5, 0.4, and 1.0, respectively.

A total of 34 shortfin mako sharks (10 male, 12 female, 12 unknown) and 46 blue sharks (45 male, 1 female) were tagged and released during the cruise. (D. Holts and D. Ramon, [619] 546-7074)

PELAGIC ECOSYSTEM MODEL DEVELOPMENT PROGRAM

Thirteenth North Pacific Albacore Workshop Scheduled

Another in a series of biannual albacore workshops is to be held at the Southwest Fisheries Science Center in December 1993 with albacore scientists from Japan, Korea, Taiwan, Canada, and the United States. In preparation for this workshop, Stock Assessment and Fishery Impact Analysis Program Leader Norman Bartoo and Pelagic Ecosystem Model Development Program Leader Pierre Kleiber have been conducting generalized additive model (GAM) analyses of the catch-and-effort data from the U.S. North Pacific troll fleet. The data span the years 1961 to the present.

GAM analyses were used to explore the statistical effects of independent variables on a dependent variable, where the effects can be expressed via non-linear transformations of the variables. The only constraint on the transformations is that they are determined by a smoothing process. The scientists searched for the optimum transformation for each independent variable.

The dependent variable selected for the analyses is the log of the catch-per-unit effort (CPUE) in spatio-temporal strata (1- or 2-degree squares and monthly time intervals) with 0.1 added to account for instances of zero catch. Various independent variables are being evaluated, the main one being time, to generate a time series of CPUE with the effects of various other independent variables removed. Additional independent variables so far include latitude, distance from the North American west coast, and Southern Oscillation Index Index (SOII), which is related to El Niño events. The latter is here dubbed an index of an index because it is the melding of two time series, neither of which covers the whole span of years of the fishery data. One is the Southern Oscillation Index for the years 1970 to present and the other is an earlier series approximating to be the Southern Oscillation Index. Where the two series overlap (years 1950 to 1985), they are similar, but not coincident. As a temporary measure, while waiting to obtain a more reliable El Niño index for the required time span, Kleiber and Bartoo merged the two series to conduct a preliminary GAM analysis. The two series were scaled to be as close as possible to each other in the overlapping years, and the average of the two were taken during those years (Fig. 2).

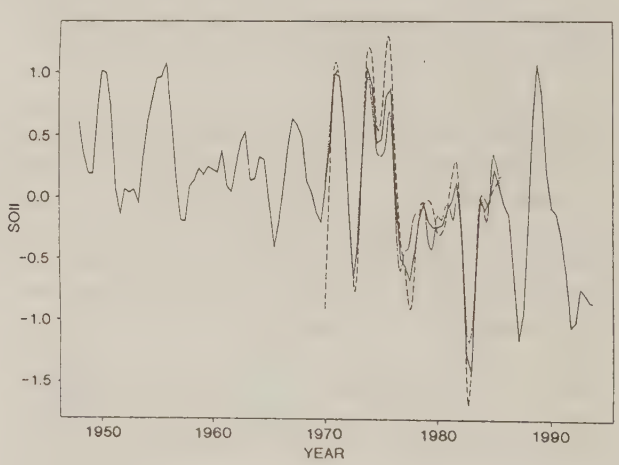

Figure 2. Southern Oscillation Index Index (SOII). Dashed and dotted lines give the two scaled time series used to construct the SOII.

Preliminary results are presented in Figure 3. The subplots are the fitted nonlinear effects of the four independent variables. The vertical scales are the same so that the relative importance of the effects can be judged from the plots. Latitude

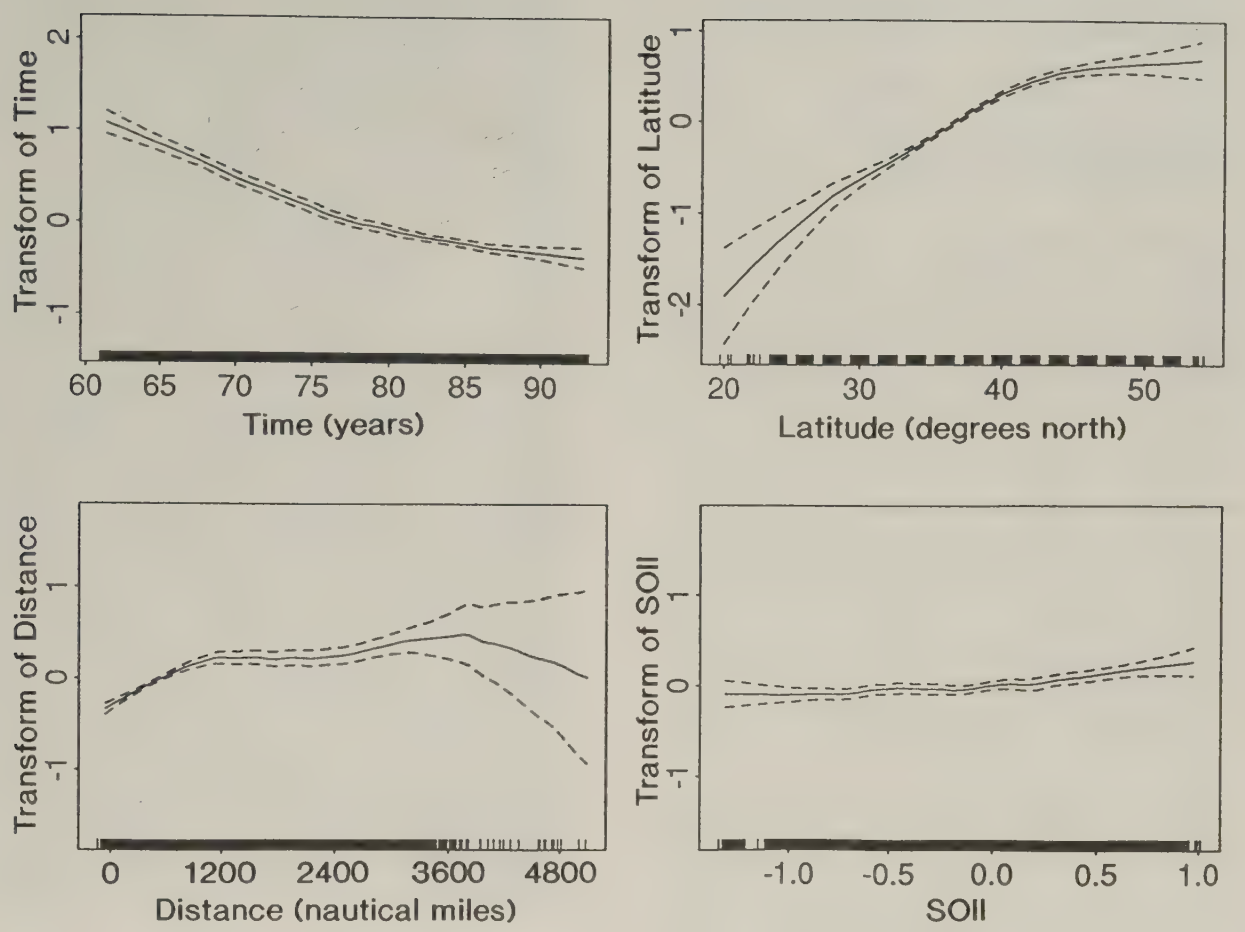

Figure 3. Preliminary generalized additive model results for log (catch-per-unit effort+0.1) modeled as a sum of smooth, non-linear transforms of four independent variates. Independent variates plotted here are transforms of time in years, latitude, distance from North American west coast (nautical miles from shore), and Southern Oscillation Index Index (SOII). Dashed lines show confidence regions at plus/minus twice the standard error. Dark marks along X axes indicate data availability.

Table 1. Contributions of the transforms of the independent variates to log (catch-per-unit effort+0.1) measured by chi-square. Independent variates are time in years, latitude, distance from North American west coast, and Southern Oscillation Index Index (SOII).

Variate	Degree of Freedom	CHI-SQ	Probability
Time	2.4	2382	< 0.01
Latitude	2.3	4446	< 0.01
Distribution	2.5	3439	< 0.01
SOII	2.9	425	< 0.01

appears to have the strongest effect, which is confirmed by the chi-square measures of contributions of the various effects on the dependent variable (Table 1). All effects are statistically significant ($P < .01$), but the magnitude of the SOII effect is substantially less than the others. The declining trend of CPUE with time is not a good sign if CPUE, with effects of variables other than time removed, is interpreted as an index of abundance. Such an interpretation is not warranted at this time because results are preliminary. A better index of El Niño, covering the years of the fishery data is needed to replace the SOII, and additional independent variates (such as upwelling index) need to be explored. Such changes could modify the trend in the effect of time seen here. (N. Bartoo, [619] 546-7073; P. Kleiber, [619] 546-7076)

TIBURON LABORATORY

Tiburon, California

GROUNDFISH ANALYSIS INVESTIGATION

Rockfish Assessments Completed

The Pacific Fishery Management Council has accepted three assessments of rockfish conducted by members of the Groundfish Analysis Investigation for publication in the Council's annual status of stocks document.

In these assessments, Fishery Biologist Jean Rogers and Mathematical Statistician James Bence used the length-based Stock Synthesis Model to assess the status of chilipepper rockfish, *Sebastes goodei*. Chilipepper rockfish are important in California landings and are exploited by recreational hook-and-line fishermen as well as commercial trawl, setnet, and hook-and-line fishermen. Input to the model included landings from the four fisheries, catch-per-unit effort from the recreational fishery, abundance indices from the triennial survey completed by the Alaska Center between 1977 and 1992, length compositions from the fisheries and triennial surveys, and age composition from the trawl fishery. The available data were not sufficient to constrain the model to a narrow range of outcomes but were sufficient to support the conclusions of previous assessments that the population was only being exploited at a moderate rate. Researchers determined that the 1984 year class was very strong and the present acceptable biological catch (ABC), 3,600 metric tons, would maintain the spawning biomass per recruit at or above 35 percent of the unfished level, which is a Council goal for rockfish management.

Groundfish Analysis Leader William Lenarz conducted an assessment of the darkblotched rockfish, *S. crameri*. Darkblotched rockfish is one of the most important of the minor species of rockfish. Most landings occur north of central California. Insufficient data were available to utilize the Stock Synthesis Model, but estimates of vital parameters were used to estimate that $F_{35\%}$ (F that reduces spawning biomass to 35 percent of the unfished level) ranges from 0.04 to 0.06. It was demonstrated that observed declines in fish size in California landings and the triennial survey were consistent with F being considerably above the $F_{35\%}$ level. Lenarz recommended that the fishery should not be allowed to expand and that the Council should consider managing the species as part of the deepwater rockfish complex. Members of this complex do not appear to be capable of sustaining high fishing rates and probably should be conservatively managed.

Rogers and Lenarz used the age-based Stock Synthesis Model to conduct an assessment of the widow rockfish, *Sebastes entomelas*, fishery. The fishery was divided into four components: southern, Oregon bottom trawl, Oregon midwater trawl, and northern. Selectivity was allowed to vary among years. Bycatch per effort of widow rockfish by the Pacific hake, *Merluccius productus*, fishery was used as an index of abundance for tuning the model. Available data are not sufficient to constrain the outcome of the model to a narrow range but were consistent with the previous assessment conducted in 1990. The results indicate that spawning biomass is slightly below 35 percent of an unfished population and that the ABC for the widow rockfish should be reduced slightly to meet the goals of the Council. (W. Lenarz, [415] 435-3149 ext. 226)

GROUNDFISH COMMUNITIES INVESTIGATION

Crown-of-thorns Sea Star Impacts Coral Recruitment

Biologists Ted Hobson, Tony Chess, and Dan Howard have been studying environmental change in coastal communities, and they have made comparisons between each of the major biographical regions: cold-temperate, warm-temperate, and tropical. Reef communities at Kona, Hawaii, representing the tropical region, have been the sites of comprehensive assessments made annually since 1985 (Fig. 1).

Among the changes documented at the Kona site are the effects of predation by the crown-of-thorns sea star, *Acanthaster planci*, on the success of recruitment by the coral, *Pocillopora meandrina*. That *A. planci* can damage coral reefs is well documented, but the concern has been with the larger, established colonies—especially those on reefs decimated by unusually large numbers of *A. planci*. On these reefs, Hobson, Chess, and Howard have been studying the less conspicuous effects on very small colonies that have become evident only with close observations and community assessments over the years.

Based on timed counts made since 1988 in various reef habitats, it has been determined

Figure 1. A photographer photographing the transect in basaltic habitat #1 at Kona, Hawaii.

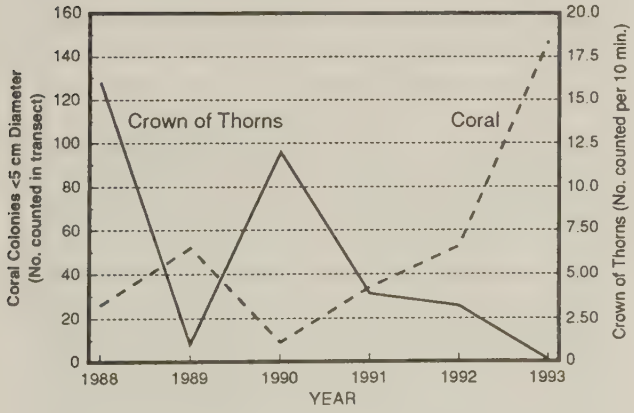

Figure 2. Numbers of the crown-of-thorns sea star, *Acanthaster planci* (solid line), and colonies of the coral, *Pocillopora meandrina*, <5 centimeters in diameter (broken line), in the basaltic habitat at Kona, Hawaii, 1988 to 1993.

that *A. planci* at Kona occurs mainly on exposed basalt, and that while not abundant during this period, its numbers have varied from year to year. Although evidence of attacks on large colonies of *P. meandrina* were readily noted, closer observation determined that attacks were more frequent on smaller colonies—those under 5 centimeters in diameter, and especially under 2 centimeters.

P. meandrina is the dominant coral in the basaltic habitat at Kona and thus constitutes one of the categories of organisms enumerated there. Based on the annual assessments, it has become evident that the number of *P. meandrina* colonies varies greatly from year to year and that this numerical variability is primarily found among the very small colonies. Most of these small colonies result from settlement during the previous year, and it has developed that an inverse relationship exists between the number of small coral colonies and the number of sea stars (Fig. 2). The possibility exists, therefore, that the damage to reef coral populations comes more from limitations on successful recruitment than from its more highly publicized predation on larger, established colonies. (E. Hobson, J. Chess, and D. Howard, [415] 435-3149 ext. 233)

GROUNDFISH PHYSIOLOGICAL ECOLOGY INVESTIGATION

Annual Ovarian Maturation Rates of Yellowtail Rockfish Significantly Related to Parental Age

Cordell Bank, a marine bank 37 kilometers west of Pt. Reyes, California, supports a population of yellowtail rockfish, *Sebastes flavidus*, which researchers at Groundfish Physiological Ecology Investigation (GPEI) have investigated since 1985. An understanding of the reproductive processes and factors that influence variations in reproductive output has been a major focus.

GPEI investigations have determined that this population of yellowtail rockfish begins sequestering vitellogenin in oocytes in August during a reproductive cycle. After internal fertilization of mature oocytes occurs, there is a 30- to 40-day intraluminal gestation of embryos. Parturition of well-developed larvae typically occurs in the month of March. Therefore, late-stage oocyte and embryonic development progresses rapidly preceding parturition. Evaluations of ovary maturation stages (OMS) of individuals collected monthly over seven consecutive reproductive cycles (1985

through 1992) revealed significant variation in oocyte maturation rates among yearly cycles.

While it is generally believed that older fish spawn earlier in a reproductive season than do younger fish, there is actually little information in the literature to demonstrate this situation. In addition, it is well established that hormonal control directly stimulates oocytes during gonadotropin-dependent stages of growth. However, rates of development may be modulated by nonendocrine sources. To understand sources of variability in yearly ovary maturation, it is necessary to consider inherent, physiological, and environmental factors as potential contributors. An assessment of the relationship between OMS and parental age on a monthly basis over the annual reproductive cycle offered the potential to reveal the influence of age on oocyte and embryo developmental rates. It was found that during early months of the reproductive cycle (April through November), age data were not related statistically to OMS. This may be due to the longer duration of previtellogenic oocyte stages of development. Consequently, the likelihood of finding enough females at various ages that were transitional between OMS 1 (early developing) and OMS 2 (early vitellogenic), or OMS 2 and OMS 3 (late vitellogenic), to test the effect of age on OMS was minimal. On the other hand, regression analysis of the OMS of females captured in January and February during late oocyte development and embryogenesis revealed significant relationships to age (Fig. 3). During January, ovary maturation ranged from late vitellogenesis, OMS 3, to eyed-larvae, OMS 8. The relationship to age continues to be significant in February as embryogenesis nears completion. Parturition is thought to occur immediately following OMS 8. (M. Bowers, [415] 435-3149 ext. 241)

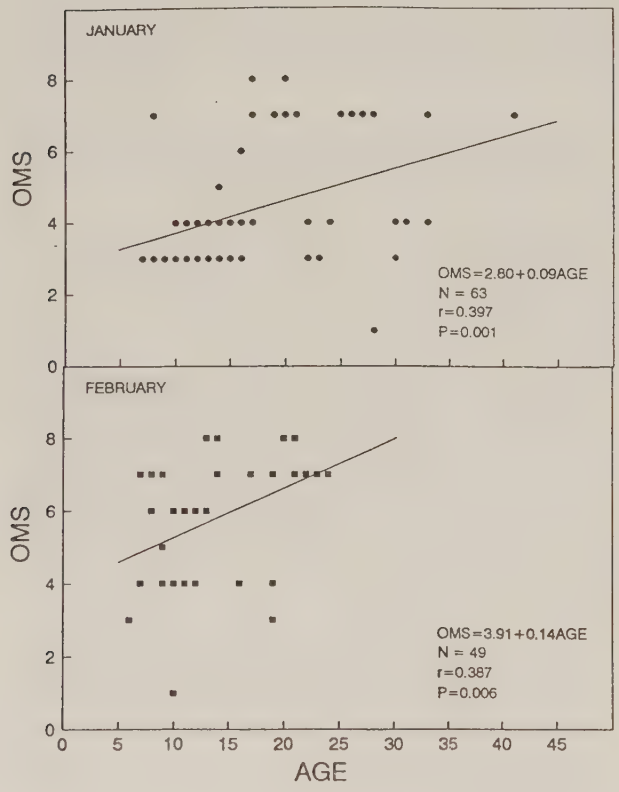

Figure 3. Relationship of ovary maturation stage (OMS) and age of yellowtail rockfish, *Sebastes flavidus*, collected from Cordell Bank since 1985. Stages 1-4: early developing and vitellogenic oocytes; Stage 5: fertilization; Stages 6-8: embryonic development.

Cordell Bank Hook-and-line Study Reveals High Species Diversity and Catch Rates

In previous Southwest Fisheries Science Center Reports of Activities, the Groundfish Physiology Ecology Investigation (GPEI) has reported partial results from a 6-year (1986-1991) hook-and-line study of fishes from the Cordell Bank Seamount in California. The primary purpose of this research was to study the reproductive life history of the yellowtail rockfish, *Sebastes flavidus*. The angling collection method, required because investigators needed live specimens in good condition, allowed them to also study the pelagic fish community that was associated with the yellowtail rockfish. The following summarizes major findings from a GPEI study of these collections, which were made on an approximate monthly basis.

When the list of 26 fish species from the study was combined with that of a previous SCUBA-observation study by the U.S. Department of Commerce in 1989[1], a total of 49 different species were compiled, reflecting the diversity of the seamount habitat. The total species composition and relative composition of GPEI's catch (Table 1) was dominated by the rockfish genus *Sebastes*—21 of 26 species were *Sebastes* species, comprising 95.6 percent of the total catch.

[1]Final Environmental Impact Statement and Management Plan for the Proposed Cordell Bank National Marine Sanctuary, Volume 1.

Table 1. List of fish species taken by hook and line from Cordell Bank. (Percent composition does not equal 100 percent due to rounding.)

Rank	Scientific Name	% Composition
1	*Sebastes flavidus*	47.40
2	*Sebastes rosaceus*	9.70
3	*Sebastes paucispinis*	9.60
4	*Sebastes serranoides*	7.00
5	*Sebastes chlorostictus*	5.10
6	*Sebastes entomelas*	5.00
7	*Sebastes pinniger*	4.10
8	*Ophiodon elongatus*	3.90
9	*Sebastes constellatus*	1.90
10	*Sebastes ovalis*	1.80
11	*Sebastes rubberrimus*	1.50
12	*Sebastes goodei*	0.60
13	*Sebastes mystinus*	0.50
14	*Sebastes elongatus*	0.40
15	*Trachurus symmetricus*	0.30
16	*Sebastes rosenblatti*	0.20
17	*Sebastes miniatus*	0.10
18	*Lepidopsetta bilineata*	0.10
19	*Oncorhynchus tshawytscha*	0.04
20	*Sebastes maliger*	0.02
21	*Sebastes hopkinsi*	0.01
22	*Sebastes saxicola*	0.01
23	*Sebastes proriger*	0.01
24	*Sebastes levis*	0.01
25	*Citharichthys sordidus*	0.01
26	*Squalus acanthias*	0.01

These results are supported by other data from a 32-consecutive-month commercial party boat survey conducted during 1987-1989, which showed 96.3 percent of the angler catch were rockfish species. Many Pacific coastwide studies also support this finding—that *Sebastes* species are the primary component of the recreational catch. This is especially true in waters off central and northern California. For example, a recent 1993 survey of commercial passenger fishing vessels (CPFV) from 1987-1991 in northern and central California (California Department of Fish and Game Administrative Report 93-4) showed 18 of the 20 most-frequently caught species were *Sebastes* species.

The dominant species in the 1986-91 GPEI study was the target species, the yellowtail rockfish. It accounted for 47.9 percent of the total catch. The succeeding four species combined with the yellowtail rockfish to account for over 80 percent of all fish landed (*S. rosaceus*, *S. pauscispinis*, *S. serranoides*, and *S. chlorostictus*). The results of the other studies mentioned above show differences in the dominance of a particular species, suggesting that it is possible to target on species-specific aggregations. For instance, the commercial party boat survey at the Cordell Bank carried out during the similar time period (1987-91) had *S. goodei* (the 12th-ranked species in the GPEI study) at 39.7 percent of the catch composition, followed by *S. flavidus* with 17.8 percent of the landing.

The catch rates observed in our study indicated that Cordell Bank was one of the most productive habitats on the Pacific coast. The overall mean catch-per-unit effort was 4.44 fish/angler/day. This was consistent with other boats at Cordell Bank. The California Department of Fish and Game (CDF&G) survey had a mean rate of 3.57. When the catch rate is expressed as the number of fish per angler day, the GPEI study's overall mean rate is 15.0 ± standard deviation of 2.6. The coastwide long-term average rate estimated for all angler-caught fish during 1980-1989 was 8.6, according to the U.S. Department of Commerce's Marine Recreational Fishery Statistics Survey of the Pacific Coast. Also, the CPFV survey for central and northern California conducted by CDF&G averaged 11.7 fish per angler day.

These comparisons demonstrate the diversity and productivity and, thus, the importance of nearshore seamounts like Cordell Bank. The complexity of the environment, the fishery oceanography, and the relationship of the seamount to the coastal habitats remain a challenge to researchers. (M. Eldridge, [415] 435-3149 ext. 243)

INFORMATION TECHNOLOGY SERVICES

National Data Management Committee Meeting Held

In the absence of Southwest Regional Data Administrator Dorothy Roll, Leader of Information and Technical Services Donald Tieman (Honolulu

Laboratory) represented the Southwest Regional area at the National Data Management Committee meeting held October 5-7 at the NMFS Silver Spring Headquarter's office.

Agenda items at the meeting included an overview of the FY 94 and 95 IT-95 budget, the draft IT-95 NMFS Wide Area Network plan, the Control Data proposed configuration management plan for the IT-95 hosts, and the new security plans mandated by the Department of Commerce.

John Oliver, NMFS Budget Officer, made a presentation on the history of the IT-95 budgets and his insight into possible outcomes in the IT-95 FY 94 and 95 budget. Following his presentation, the primary focus of the group discussions was to identify and evaluate alternatives for supplementing the IT-95 appropriated funds to procure the hosts for La Jolla, Honolulu, Auke Bay, and Woods Hole and to support site preparation, training, and software conversion. The options selected for recommendation to the Board of Directors at their December meeting were (1) taxing or redirecting the external funds, such as the Earth System Data and Information Management funds, the NMFS share of the NOAA High Performance Computing and Communications funds, and the Magnuson Act funds from fines levied by Enforcement; and (2) taxing NMFS Data Management off the top before distribution.

Gary Falk, chief of the NOAA Automated Data Processing (ADP) and Telecommunications Branch, presented an overview of the NOAA Network Integration Strategy and Interoperability Profile and discussed various projects associated with Internet. Mel Booth, Control Data Telecommunications Specialist, presented his draft NMFS Wide Area Network Plan, which was based on interviews he conducted during his visits to the four regional field sites. The draft plan generated several hours of dialogue on alternative configurations for the NMFS telecommunication backbone and regional subnets and on the management of the network system. Due to the prohibitive cost of T1 lines (high-capacity telephone circuits capable of carrying 24 telephone lines) for the backbone, the group agreed to initially install 56 kilobit-per-second lines to link the five regional offices, the five science centers, and Headquarters. According to the draft plan, reconfiguration and upgrades would be made when usage warranted.

Strategies for ensuring successful implementation of the IT-95 host at each site were discussed by the Committee. Possible strategies included building internal management and user support through frequent communication, formal and self-paced user training, teams for troubleshooting or assisting during peak workloads, periodic newsletters, a system administrators' network, and local/national user groups.

Becky Vasvary, the NOAA security officer for the current Department of Commerce ADP and Telecommunication Policy discussed the process for system security plans and system accreditation under the Computer Security Act of 1987.

During the review of the NOAA's Information Resource Management (IRM) Policy, participants were alerted that the IRM approval procedures apply, not only to procurement requests for computer-related resources but also to all forms of voice and voice-grade telecommunications equipment, lines, and support services. Related items are maintenance modifications to existing services, wiring, and instruments, including cellular phones and fax machines. The Regional Data Base Administrators (RDBA) are not authorized to approve these telecommunication procurement requests. Procurement requests for these items must be forwarded through the RDBAs with the appropriate Requirements Initiative Number to Michael Fraser, Office of Research and Environmental Information, Data Management Division, for approval. In order to show NMFS compliance with the NOAA IRM policy in the event of an audit, he requested that RDBAs forward copies of all recent purchases for telecommunication installations, service modifications, and equipment. (D. Roll, [619] 546-7057)

PUBLICATIONS

Published

Bagarinao, T., and R. D. Vetter. 1992. Sulfide-hemoglobin interactions in the sulfide-tolerant salt marsh resident, the California killifish *Fundulus parvipinnis*. J. Comp. Physiol. B 162:614-624.

This paper describes experiments on the California killifish, *Fundulus parvipinnis*, and to a lesser extent, the long-jawed mudsucker, *Gillichthys mirabilis*, to determine the role of hemoglobin in aggravating or ameliorating sulfide toxicity. Both species are remarkably tolerant to sulfide and experience potentially high levels of sulfide in their salt marsh habitat. The researchers found that the blood of these two species, as

well as of several other marine fishes, has high sulfide-oxidizing activity, based on a spectrophotometric assay using the artificial electron acceptor BV but that the blood neither aggravates nor ameliorates sulfide toxicity. The results are important for the contrasts and clarification they provide relative to previous studies.

Balazs, G. H. 1993. Appendix A: Annotated list of shark attacks in the Hawaiian Islands, 1779-1993. *In* Borg, J., Tigers of the sea: Hawaii's deadly sharks, p. 63-83. Mutual Publishing, Honolulu, HI.

Bartoo, N., and D. Holts. 1993. Estimated drift gillnet selectivity for albacore, *Thunnus alalunga*. Fish. Bull., U.S. 91(2):371-378.

The North and South Pacific drift gillnet (DGN) fisheries have exerted a substantial, but as yet unknown, mortality on albacore, Thunnus alalunga, populations. Several DGN experimental surveys conducted in these oceans have produced data on albacore distribution and gear selectivity. Knowledge of DGN selectivity is useful for applying complex population-dynamics techniques to the albacore population. In 1984-85 the Southwest Fisheries Science Center (SWFSC) undertook an experiment to quantify DGN mesh-size selectivity for albacore. The experiment produced size-selectivity data for a single mesh size used in the U.S. DGN commercial fishery for albacore (184 mm) in the eastern North Pacific Ocean. Other experiments designed to sample albacore, using other mesh sizes which produced complementary data used in this study, were conducted by the Japan Marine Fishery Resource Center in 1980 (JAMARC 1983), 1982 (JAMARC 1985), and 1983 (JAMARC 1986). The objective of the SWFSC analysis was to quantify drift gillnet mesh-size selectivity for albacore, using existing data collected from various experiments and surveys in the Pacific Ocean.

Carretta, J. V., and K. A. Forney. 1993. Report of the aerial surveys for marine mammals in California coastal waters utilizing a NOAA DeHavilland Twin Otter Aircraft March 9 - April 7, 1991, February 8 - April 6, 1992. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFSC-185, 92 p.

Eckert, K. L. 1993. The biology and population status of marine turtles in the North Pacific Ocean. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFSC-186, 156 p.

Eliason, J. J., J. R. Henderson, and M. A. Webber. 1993. Hawaiian monk seal observations at French Frigate Shoals, 1985. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFSC-187, 46 p.

Haight, W. R., J. D. Parrish, and T. A. Hayes. 1993. Feeding ecology of deepwater lutjanid snappers at Penguin Bank, Hawaii. Trans. Am. Fish. Soc. 122:328-347.

Six of the seven lutjanid species that commonly occur in the major deepwater snapper fishery at Penguin Bank, Hawaii, were simultaneously collected by line fishing. The catch rate of each species showed diel variability, the patterns of some species being distinctly different. Depth distribution of feeding, as indicated by depth of capture, differed considerably among species. Size (fork length) of the predator species did not appear to be stratified by time of capture (daylight versus darkness) or median capture depth. Regurgitation of gut contents seemed reduced when fish were retrieved at a rate slower than used in commercial practice but rapid enough to prevent death or morbidity while hooked. Food remaining in line-caught specimens appeared representative of what was originally eaten. Major diel and seasonal shifts in diet were found only in *P. filamentosus* and involved the relative proportions of fish and especially major planktonic groups. Information on diet composition and depth and time of feeding (catch) suggests that considerable resource partitioning occurs among these deepwater snappers.

Hewitt, R. P., and D. A. Demer. 1993. Dispersion and abundance of Antarctic krill in the vicinity of Elephant Island in the 1992 austral summer. Mar. Ecolog. Prog. Ser. 99:29-39.

Antarctic krill, *Euphausia superba*, distribution and abundance were estimated from four acoustic surveys conducted in the vicinity of Elephant Island, Antarctica, from mid-January to mid-March 1992. The first and last surveys covered a 105-by-105-nm study area centered on Elephant Island; the second and third surveys covered a 60-by-35-nm area immediately north of Elephant Island. During the first survey, krill were distributed in a wide band extending along the north side of Elephant Island and wrapping around the western end; biomass was estimated to be 2.2 million metric tons (t). During the second survey, the highest densities of krill were over the shelf extending to the northwest from Elephant Island and including the Seal Island archipelago; high densities of krill also extended off the shelf from the northeast end of Elephant Island into deeper water. Biomass in the smaller survey area was estimated to be 0.7 million t. Three weeks later, high krill densities were still apparent in the vicinity of Seal Island, but the area of high density previously mapped off the northeast end of Elephant Island had diminished considerably; biomass was estimated to be 0.4 million t. During the final survey, conducted 6 weeks after the first survey, krill were mapped in reduced densities primarily to the west of Elephant Island; biomass over the larger survey area had declined to 1.1 million t.

Hinckley, S., K. Bailey, S. Picquelle, M. Yoklavich, and P. Stabeno. 1993. Age-specific mortality and transport of larval walleye pollock, Theragra chalcogramma, in the western Gulf of Alaska. Mar. Ecolog. Prog. Ser. 98:17-29.

A field study was conducted in May 1988 to estimate mortality rates of individual cohorts of larval walleye

pollock, *Theragra chalcogramma*, in Shelikof Strait, Gulf of Alaska. Two surveys of the area of larval distribution were done and daily mortality rates estimated from changes in abundance of each cohort. This study was designed to minimize potential sources of bias to mortality estimates. The age-specific mortality rates from this study were low compared to rates previously estimated for larval walleye pollock. Four significant mortality estimates, ranging from 0.041 to 0.076 d^{-1}, came from among the youngest cohorts. The low larval mortality rates in 1988 coincided with very calm ocean conditions. Larval drift rates estimated in this study were coherent with the movement of a satellite-tracked drift buoy and averaged 3.1 to 3.9 cm s^{-1}, which is comparable to rates reported from other studies.

Macewicz, B. J., and J. R. Hunter. 1993. Spawning frequency and batch fecundity of jack mackerel, *Trachurus symmetricus*, off California during 1991. Calif. Coop. Oceanic Fish. Invest. Rep. 34:112-121.

In southern California waters, during March-April 1991, the average mature female jack mackerel, *Trachurus symmetricus*, spawned every 5 days, and 8 percent of the females spawned at 1-3 day intervals. The average relative batch fecundity was 112 oocytes per gram female weight (without ovary). Batch fecundity was lower for females that had spawned within the last 3 days than for females in which no evidence existed for a previous spawning.

Philbrick, V. A., P. C. Fiedler, and S. B. Reilly. 1993. Report of ecosystem studies conducted during the 1991 California Coastal Marine Mammal Survey aboard the research vessel *McArthur*. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFSC-184, 41 p.

Prager, M. H., and A. D. MacCall. 1993. Detection of contaminant and climate effects on spawning success of three pelagic fish stocks off southern California: northern anchovy, *Engraulis mordax*; Pacific sardine, *Sardinops sagax*; and chub mackerel, *Scomber japonicus*. Fish. Bull., U. S. 91(2):314-331.

The model, a simple biostatistical model of reproductive success (logarithm of recruits/spawner) applied to three coastal pelagic fish stocks off southern California: northern anchovy, *Engraulis mordax*; Pacific sardine, *Sardinops sagax*; and chub mackerel, *Scomber japonicus*, was used to detect possible influences of gross climatic conditions and contaminant loadings on reproduction in the three stocks. Data included several decades of annual estimates of recruitment and stock size, monthly measures of climate, and annual estimates of contaminant loadings; the model included a compensatory stock-size component before adding environmental effects. The study was meant to generate, rather than test, hypotheses. For chub mackerel stock, climate, but no contaminant, influences were detected on reproductive success. For northern anchovy stock, no climate or contaminant influences were detected on spawning success, but negative results may reflect low statistical power rather than absence of contaminant influences. For Pacific sardine stock, no consistent climate influences were detected, but a strong negative correlation with contaminant loadings was found. Results are consistent with the hypothesis that contaminant loadings accelerated the collapse of the Pacific sardine stock while it was under stress from severe overfishing. Although many scientific questions about validation of models, mechanisms of action, and identity of specific deleterious contaminants remain to be answered, the observed data are well described by the hypothesis of contaminant-mediated decline.

Schroeter, S. C., J. D. Dixon, J. Kastendiek, R. O. Smith, and J. R. Bence 1993. Detecting the ecological effects of environmental impacts: A case study of kelp forest invertebrates. Ecological Applications 3:331-350.

The Before-After/Control-Impact (BACI) sampling design, in which Impact and Control sites are sampled contemporaneously and repeatedly in periods Before and After human perturbation of interest, is used to examine the ecological effects of the cooling water discharge from a coastal nuclear power plant in southern California. Design results suggest some general lessons about the process of impact assessments that are applicable in many ecological contexts, and the researchers concluded that there were significant environmental impacts to the kelp forest invertebrates studied: (1) the effect size was generally very large (≈ 75 percent); (2) there was a consistent pattern among species; (3) there were two Impact sites, and effects were larger at the site nearest the discharge; (4) the observed effects accorded with physical changes that could be linked with the source of impact; and (5) a number of alternative mechanisms, unrelated to the source of impact, were examined and rejected. Monitoring studies of relatively long-lived organisms will often have low power to detect ecologically significant changes in density: The present study of kelp forest organisms extended over nearly 6 years, yet the resulting statistical tests generally had power of < 30 percent to detect a doubling or halving in density at a significance level of .05. In such a community, it would be a mistake to conclude that there were no significant ecological effects based on conventional hypothesis tests. Unless there is a willingness to accept the fact that changes in natural populations on the order of 50 percent will often go undetected, the standards and types of evidence used to demonstrate environmental impacts must be changed.

Skillman, R. A., C. H. Boggs, and S. G. Pooley. 1993. Fishery interaction between the tuna longline and other pelagic fisheries in Hawaii. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFSC-189, 46 p.

Squire, J. L., Jr. 1993. Relative abundance of pelagic resources utilized by the California purse-seine fish-

ery: Results of an airborne monitoring program, 1962-90. Fish. Bull., U.S. 91(2):348-361.

During the period 1962-90, an aerial monitoring program conducted in cooperation with aerial spotters searching for pelagic fishes off California and Baja California, Mexico, resulted in the development of an index of apparent abundance for six species of fishes: the northern anchovy, *Engraulis mordax*; Pacific sardine, *Sardinops sagax*; Pacific bonito, *Sarda chiliensis*; Chub mackerel, *Scomber japonicus*; jack mackerel, *Trachurus symmetricus*; and bluefin tuna, *Thunnus thynnus*. Based on data collected during the aerial surveys, all species exhibited large fluctuations in apparent abundance over time and several species appear to be fluctuating unpredictably with respect to species abundance over time. Aerial indices were also compared with available total, spawning, and larval biomass estimates developed for several species. The most significant correlation of the aerial index was between the northern anchovy and Pacific sardine larval indices.

Taylor, B. L. 1993. "Best" abundance estimates and best management: Why they are not the same. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFSC-188, 20 p.

Two management strategies are compared, one which uses the mean (or "best") estimate of abundance (N_{MEAN}) and one which uses a minimum estimate of abundance (N_{MIN}). The strategies are compared (using simulations) in the context of proposed management regimes for marine mammals. The calculation of the number of animals which can be removed from the population (by incidental fishery mortality) uses an estimate of abundance. With use of N_{MEAN}, the less precise the abundance estimate, the less conservative the management of the population. With the precision common to many marine mammal population estimates, the use of N_{MEAN} clearly does not meet management objectives. Use of N_{MIN} manages more conservatively when precision is low. The N_{MIN} strategy is superior given management objectives. It was concluded that choice of the minimum abundance level to be used would be aided by availability of quantitative management objectives.

Taylor, B. L., and T. Gerrodette. 1993. The uses of statistical power in conservation biology: The vaquita and Northern Spotted Owl. Conservation Biology 7(3):489-500.

The consequences of accepting a false null hypothesis can be acute in conservation biology because endangered populations leave little margin for recovery from incorrect management decisions. The concept of statistical power provides a method of estimating the probability of accepting a false null hypothesis. Taylor and Gerrodette illustrate how to calculate and interpret statistical power in a conservation context with two examples based on the vaquita, *Phocoena sinus*, an endangered porpoise, and the Northern Spotted Owl, *Strix occidentalis caurina*. The vaquita example shows how to estimate power to detect negative trends in abundance. The researchers demonstrate that detection of a decline should not be a necessary criterion for enacting conservation measures for rare species. For the Northern Spotted Owl, estimates of power allow a reinterpretation of results of a previous demographic analysis that concluded the population was stable. The reinterpretation shows that the previous conclusion was not justified. They also show how calculations of power can be used to compare different methods of monitoring changes in the size of small populations.

Wibbels, T., G. H. Balazs, D. W. Owens, and M. S. Amoss, Jr. 1993. Sex ratio of immature green turtles inhabiting the Hawaiian Archipelago. J. Herpetol. 27(3):327-329.

Approved by Science and Research Director, SWR

Boehlert, G. W., and B. C. Mundy. Vertical and onshore-offshore distributional patterns of tuna larvae in relation to physical habitat features. For consideration for publication in Marine Ecology Progress Series.

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Brill, R. W., G. H. Balazs, K. N. Holland, R. K. C. Chang, and S. Sullivan. Submergence intervals, movements, and habitat use of normal and tumor-afflicted Hawaiian green turtles, *Chelonia mydas*, determined by ultrasonic telemetry. For consideration for publication in Canadian Journal of Zoology.

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MacCall, A. D., and K. Tatsukawa. Theoretical effects of habitat selection on distribution and productivity of whales. For publication in 44th Annual Report of the International Whaling Commission.

Mundy, B. C. Policies, legislation, and other activities related to nonindigenous marine organisms in the state of Hawaii. For consideration for publication in NOAA Technical Report NMFS.

Polovina, J. J. The case of the vanishing lobster. For consideration for publication in Natural History.

Administrative Reports

Administrative Reports are strictly for internal use only and are not to be cited or treated as publications.

Honolulu, Hawaii

Dailey, M., and R. Morris. 1993. Relationship of trematode spirorchid parasites and their eggs to the occurrence of fibropapillomas affecting the green turtle, *Chelonia mydas*. SWFSC Admin. Rep., Honolulu, H-93-10C, 24 p.

Gilmartin, W. G. 1993. Hawaiian monk seal work plan, fiscal years 1994-96. SWFSC Admin. Rep., Honolulu, H-93-16, 83 p.

La Jolla, California

Julian, F. 1993. Pinniped and cetacean mortality in California gillnet fisheries: Preliminary estimates for April 1 to June 30, 1992. SWFSC Admin. Rep., La Jolla, LJ-93-19, 18 p.

Barlow, J., J. Sisson, and S.B. Reilly. 1993. Status of California cetacean stocks, a summary of the workshop held on March 31 to April 2, 1993. SWFSC Admin. Rep., La Jolla, LJ-93-20, 41 p.

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